REPORT 1982 D

GILT EDGE 40-FOOT

COLUMN TESTS

Prepared for

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GILT EDGE 40 FOOT COLUMN TESTS

CONCLUSIONS

Four cyanide leach tests were run on samples of Gilt Edge ores in columns 40 feet high and 4 feet in diameter. Each column held nearly 25 tons of ore. The function of the tests was to provide scaleup data from the extensive series of small bucket leach tests which have been run on the ores.

Figures 1 and 2 present graphs showing gold recovery versus time. The graphs demonstrate an average recovery from oxidized ores on tall columns of 74 percent, and they show essentially the same gold recovery in tall columns as in small bucket tests. Most other test parameters, except for the rate of gold recovery, were the same in the tall column tests as in the small bucket tests.

The results provide two significant findings:

1. Small bucket leach tests can be used to accurately predict recovery in tall column tests.

2. There are no chemical problems with leaching Gilt Edge ores in 40-foot high heaps. This favorably affects heap leach economics for two reasons:

A. High rainfall and short summer season at Gilt Edge provide less than ideal conditions for leaching. Measures to permit "partially" enclosed year-round leaching would solve the problems, but add to costs. These costs decrease as heaps get higher. Partially enclosed 40-foot high heaps at Gilt Edge will show roughly the same operating costs as open 20-foot high heaps in central Nevada.

B. The ability to construct 40-foot high heaps means, that adequate area for heap leaching is probably available on land already controlled by the company. Furthermore, the land requirements for heap leaching will be roughly the same as those for building a conventional mill and tailings pond.

SUMMARY OF TEST RESULTS

For tests one, two and three, rigorous sampling of the test tailings has been performed, and thus, leach behavior is accurately known. A total of 22 laboratory bucket leach tests have been run on the samples, and these results are tabulated at the beginning of the Appendix.

The recovery from the tall columns one, two and three, averaged 74 percent of contained gold, whereas the recovery in corresponding small bucket leach tests (50 lbs ore each) averaged 73 percent. Recovery curves which show this data are presented in Figures 1 and 2.

In all cases, recovery from the tall columns was slower than it was from the small buckets. In 30 days of leaching, average recovery from the bucket tests was 61 percent, whereas 63 days of leaching were required to achieve the same recovery in the tall columns. This time delay, of 2:1 or 3:1 in rate of recovery, has been noted elsewhere in published papers by Kappes, and by Paul Chamberlain of Occidental, as it applies between bucket tests and large field heap leach tests. Appearance of an identical response in these tests, suggests that the tall columns may be good models for high field heaps.

Precious metal recovered from the four columns averaged 40.8 percent gold, 59.2 percent silver. This compares with an average for the nine bucket tests of 55.3 percent gold, 44.7 percent silver. Chemical consumption in the four columns averaged 1.6 pounds sodium cyanide and 0.5 pounds hydrated lime per ton of ore.

Since the tall columns yielded the predicted recovery, there are apparently no chemical barriers to building production heap leaches 40 feet high at Gilt Edge. The determination that 40 foot heaps are possible means, that 10,000,000 tons of Gilt Edge ore could be leached within an area of 150 acres. This is approximately the same land area that would be required for a conventional mill and tailings pond for the same production level. Thus, land area requirements will not be a significant factor in selection of processing alternatives at Gilt Edge.

The fourth leach column was loaded with 20 tons of a high-sulfide (approximately 25 percent pyrite) ore from the King Tunnel, Dakota Maid Zone. As the ore was loaded into the column, it was bedded with enough limestone to neutralize all the contained pyrite. In production heap leaches, this procedure would prevent the long-term danger of acid mine drainage from the heaps. Since the Gilt Edge ore averages only 3 percent pyrite, the cost of adding the limestone would add only about $0.30 per ton to the production costs.

Estimated response from 70 days leaching of this column is presented in Figure 2. Apparent recovery of gold has exceeded the recovery from the same material in small bucket leach tests. This effect is thought to be due to sampling errors (the ore in the bucket test is lower grade than the actual column), rather than to differences in behavior.

Cyanide leaching of the high sulfide ore in column 4 was terminated in mid-1981. The test will be maintained indefinitely in the column, and water will be added to the top of the column to approximate normal rainfall. Drainage from the column will be continuously checked to determine cyanide, gold, and heavy metals content, and pH.

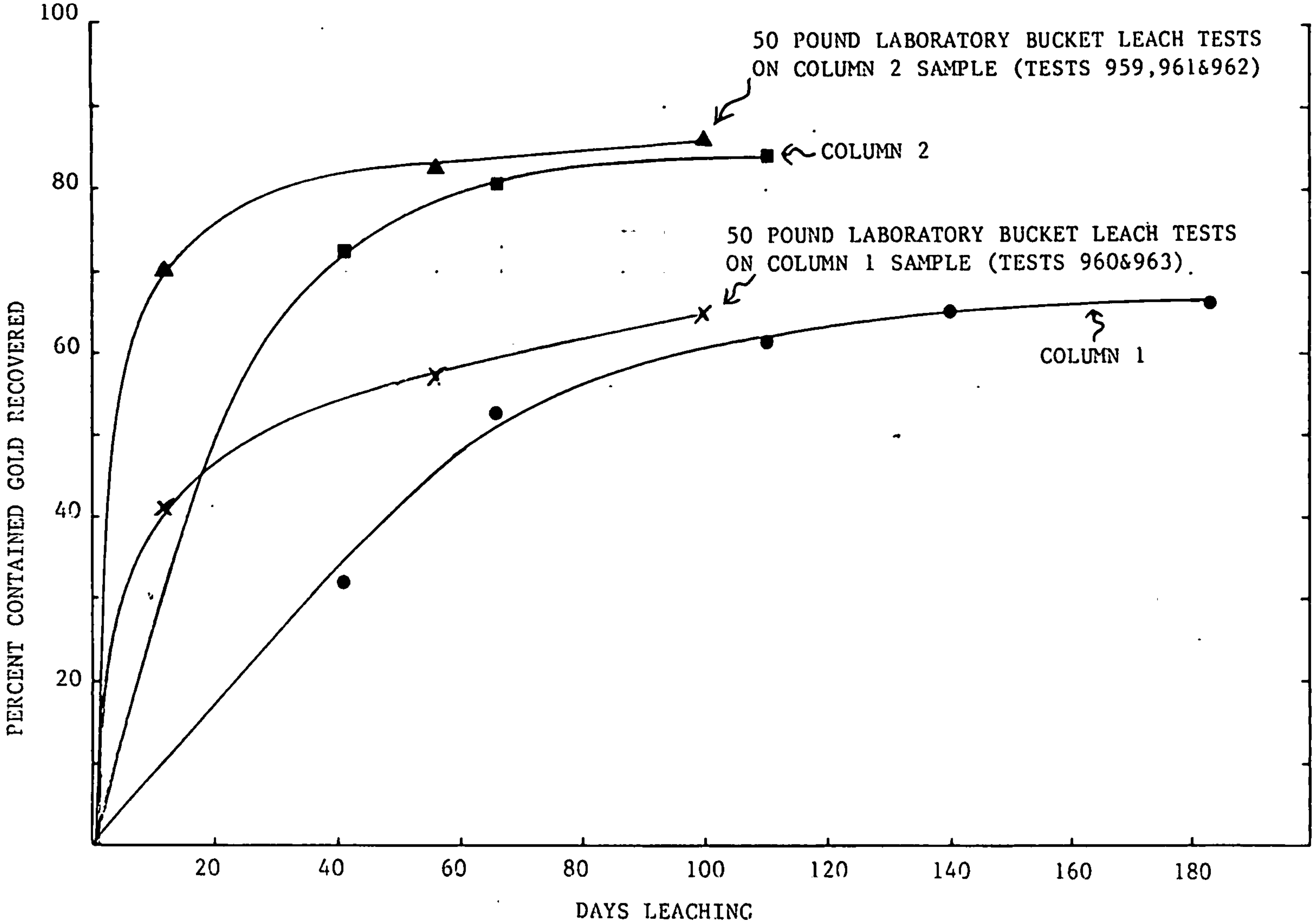


FIGURE 1. GOLD RECOVERY:GILT EDGE 40 FOOT COLUMN
TESTS ON UNCRUSHED ORES.
RATTLESNAKE TUNNEL SAMPLES:COLUMNS 1&2

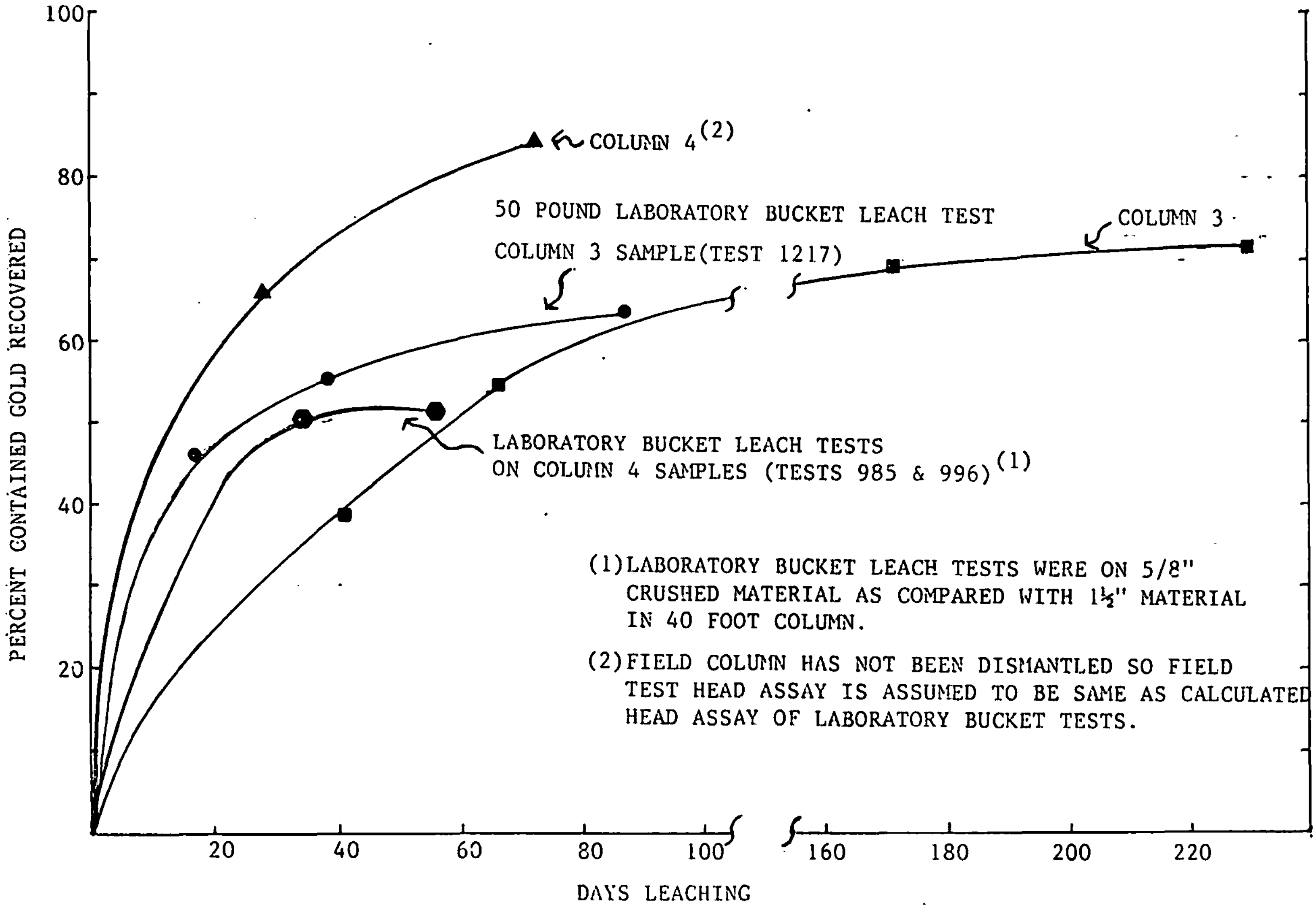


FIGURE 2 GOLD RECOVERY: GILT EDGE 40 COLUMN TESTS
UNCRUSHED DAKOTA MAID SAMPLE: COLUMN 3
CRUSHED KING TUNNEL SAMPLE: COLUMN 4

SUMMARY OF TEST DETAILS

Size of Ore in Tests. Columns one through three contained oxidized ores. Columns one and two were composite underground samples from the Rattlesnake Tunnel, Sunday Zone. Column three contained a sample of ore from the face of a new tunnel, approximately 80 feet below the surface, in the northern end of the Dakota Maid Zone. All three of the columns were loaded with "mine run" sized ore, essentially a well-blasted material taken from the underground drifts (a small percentage of the sample consisted of rocks larger than 12-inches diameter; these were removed manually while the columns were being loaded).

As noted, the fourth column was loaded with high-pyrite ore from the King Tunnel. The ore for this test was crushed to 1-1/2 inches and was mixed with 1/2-inch crushed limestone equal to 25 percent of the ore weight.

Test Histories. A brief summary of the individual column test histories is presented below.

Column 1 contained a composite Rattlesnake Tunnel oxidized ore sample. The leach solutions exiting the columns were marginally acidic (pH 5) for the first 30 days of the test. Small amounts of total cyanide were measureable after the sixth day, but free cyanide was not detectible until the thirtieth day. The total chemical consumption in the test was 1.51 pounds NaCN, and 0.65 pounds $Ca(OH)_2$ per ton of ore, and 40 percent of this occurred in the first 30 days. In spite of the low pH, gold recovery began fairly early, and 50 percent of the total recovered gold (33 percent of contained gold) was recovered in the first 41 days leaching. The leach solutions contained only moderate amounts of copper (they peaked at 75 ppm).

Column 2 contained a second composite of Rattlesnake Tunnel oxidized ore. The two composites had been selected primarily by color and location: column one contained ore colored red-brown by iron oxides from directly beneath the Sunday Pit; whereas column two contained ore colored by yellow-brown iron oxides from the western end of the ore zone. The leach solutions exiting column 2 were alkaline on day one, but measureable free cyanide was not detected until day 16. The total chemical consumption was 1.08 pounds NaCN and 0.48 pounds $Ca(OH)_2$ per ton of ore. Copper levels in solution were low, peaking at 120 ppm.

Column 3 contained oxide ore from the north end of the Dakota Maid Zone. Initial solutions from this column were alkaline and contained measureable cyanide. Chemical consumption in the test totalled 2.8 pounds NaCN and 0.63 pounds $Ca(OH)_2$ per ton of ore. Copper levels in solution peaked at the relatively high level of 250 ppm. The recovery curve for this test (Figure 2) is almost an exact duplicate of the recovery curve for column one.

Column 4 contained high-sulfide ore from the King Tunnel. In small laboratory bucket leach tests the ore showed identical recoveries whether or not the ore was bedded with limestone, however, the ores without limestone had effluent solutions which were significantly acidic. The tall column test contained limestone, and the behavior of this column was similar to the small bucket test with limestone. Initial solutions exiting the column were alkaline, and measureable free cyanide appeared on day 9. Total chemical consumption was very low - 0.77 pounds NaCN and 0.33 pounds $Ca(OH)_2$ per ton of ore. Copper levels in solution peaked at the relatively high level of 200 ppm.

The remainder of this report presents details of test construction, operation, and performance. A list of important test details and the pages on which they are discussed, is provided in the Table of Contents.

COLUMN DESIGN AND CONSTRUCTION

Figure 3 presents a photograph of the columns part way through construction. The columns were built from six foot sections of concrete sewer pipe, stacked atop one another.

The columns rest on a 6-inch thick, 16-foot square, reinforced concrete floor slab. The slab was poured on naturally-compacted, undisturbed gravel sediment.

FIGURE 3. Photograph showing partially erected columns and ore bucket used to load 25 tons of ore into each column. The 40-foot columns were erected in segments. The ore bucket, shown in the foreground, and a second one with a bottom-dump gate, were used to load ore into the columns, however, it was spread manually to avoid segregation.

The bottom segment of pipe for each of the four columns was specifically cast with an integral end (bottom), and was set directly on the floor slab. The inside of this segment was painted with waterproof concrete paint, then two coats of waterproof epoxy paint. Each of the upper sections was painted internally with waterproof concrete paint.

Figure 5 shows the crane that was used to construct the columns. To facilitate lifting the pipe into place, steel lifting inserts were cast into the inside walls of the columns. Cable slings were bolted to the inserts, and the sections were lifted into place. All four sections on adjacent columns were erected simultaneously. During installation, small steel shims were inserted to make the columns vertical. Then the "packerhead culvert" construction joint was sealed with silicone sealant.

After the column segments were firmly seated, wood 4 x 6's (visible in Figures 3 and 4) were inserted in the central gap between columns. The columns were compressed tightly against the wood, using 3/16 galvanized cable looped around the columns and tensioned with a turnbuckle. The four columns were thus keyed together by friction to provide a structural monolith approximately 10 by 10 feet at the base, and forty feet high.

It is important to note that the columns were designed as a temporary industrial structure. Normal design factors such as functional and weather-caused static and dynamic loading, were taken into account in the design. The design did not adhere to building codes, however. Integrity of the structure requires periodic examination of the foundation, measurement of the verticality, and re-tensioning of the cables. The structure remained competent and stable, with no changes from its construction in December, 1980, through May, 1982.

During initial construction, columns one, two and three were loaded with ore as the columns were built (as soon as each group of four pipe sections was in place), using a bottom-dump ore bucket lifted by the crane. The fourth column was loaded the same way, but loading of the entire 40 foot height took place after erection was completed.

FIGURE 4. Photograph of the interior of the finished column building. The four columns were structurally tied together by tensioning them with cables against wood spacers. The column building consisted of reinforced, prefabricated panels, which were structurally supported by the leach columns.

FIGURE 5. Photograph showing 40-foot leach columns during erection. The column segments were lifted into place using a rented hydraulic crane, then leveled, and sealed. Lifting was facilitated by lifting lugs, which were specially cast into the interior column walls.

Since leaching was scheduled to take place throughout the winter, the columns were enclosed in a 16 foot square, five story high, building (Figure 6). The building was purchased as a panel-system building, and erected by project personnel. The building is structurally supported by the leach columns. Wood support struts can be seen in Figure 4.

Total cost to purchase and erect the column systems and building was approximately $55,000.00.

FIGURE 6. Exterior photograph of finished column building. The columns were enclosed so that leaching could continue during the winter of 1980-81. The leach equipment included two 55-gallon solution storage vessels, which were housed, along with a small laboratory, in a ground-floor "wing" visible in the photo above. The building was heated with two propane fired furnaces.

ORE SELECTION AND SAMPLING PROCEDURES

The location of all the sampling sites for the four column tests is shown on the map in Figure 7.

For columns one and two, five 15-ton bulk samples were taken from the Rattlesnake Tunnel during the 1980 summer field season. These five samples were taken at the same locations as the 1979 one-ton bulk samples, numbers 4, 5, 8, 9 and 14. At each sample location, the drift was slabbed away to yield a flat surface and the rock disposed of in one of the side drifts. A 7 x 7 x 6 foot section was then drilled and blasted. The rock was mucked out with a Melroe bucket loader with a one-fifth yard bucket, and stored on covered wood platforms outside the entrance to the Rattlesnake Tunnel. The rock at the sample site for column one was stained predominantly red-brown with iron oxides. The location of this sample was near the central ore "pipe". a zone of former high sulfides, directly beneath the Sunday Pit. The rock for column two was taken from a less intensely mineralized area on the western edge of the Sunday Zone, and was colored predominantly yellow-brown.

In addition to the five 15-ton bulk samples from the Rattlesnake Tunnel, two 25-ton bulk samples were taken, one from the King Tunnel (for column four) and one from the face of a new, 120 foot long sampling adit, called the Laron Tunnel (for column three).

SAMPLE PREPARATION

The five 15-ton bulk samples from the Rattlesnake Tunnel and the 25-ton bulk sample from the Laron Tunnel, were used without any additional crushing. During the loading of the columns, rocks larger than 12-inches were removed by hand from these samples.

The 25-ton bulk sample from the King Tunnel was crushed to 1-1/2 inches through a jaw crusher before loading into the column.

FIGURE 7. GILT EDGE 40 FOOT COLUMN TEST REPORT
LOCATION OF BULK SAMPLES
0 25 50 75 100 150 200 ft
Scale 1" = 100 ft
D. Kappes
11 July 1982
COLUMN 3
COLUMN 4
COLUMN 1
COLUMN 2
LARON (1980)
GILT EDGE INCLINE
DAKOTA MAID PIT
SUNDAY PIT
HEAP LEACH SAMPLE SITE
SUNDAY TUNNEL
RATTLESNAKE
#5
#4
#8
#14
#9
DDH 20
DDH 27
DDH 22
DDH 12
DDH 13
DDH 21
DDH 7
DDH 14
DDH 15
DDH 16
DDH 19

COLUMN LOADING

The five 15-ton bulk samples from the Rattlesnake Tunnel were used to make two composite samples for columns 1 and 2. Samples 4 and 5 were used for the column 1 composite, while samples 8, 9 and 14 were used to make the column 2 composite. The procedure used was to take alternating one-third yard endloader bucket loads from the 15-ton stockpiles, removing pieces of rock larger than 12-inches, and then loading them into a one-half yard ore bucket. The ore bucket was hoisted by crane, lowered into the column, then dumped. Since the columns were loaded in 4-foot sections, it was fairly easy for the bucket operator to manually position the dump site so that the ore was distributed evenly in the columns.

Column 3 was loaded with the 25-ton bulk sample from the Laron Tunnel, in an identical fashion.Column 4 was loaded with the bulk sulfide ore sample from the King Tunnel, with 25 percent by weight limestone (crushed to 1/2-inch) added. The ore and limestone were mixed, one bucket load at a time, and then placed into the column.

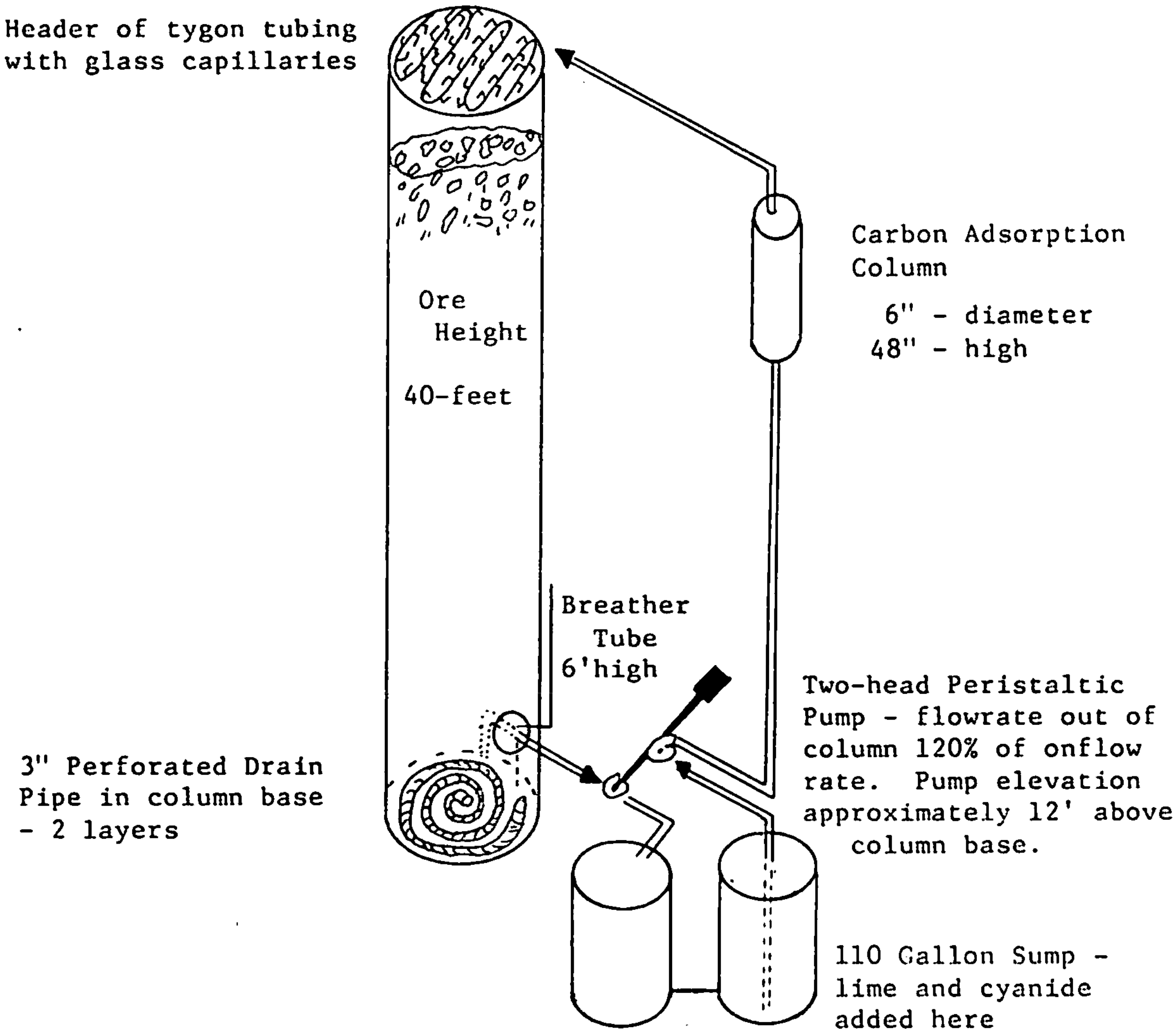
COLUMN LEACH TEST APPARATUS

The flowsheet of the system used for the 40 foot column leach tests is shown in Figure 8.

In the apparatus shown in Figure 8, the 40 foot column was filled with the rock to be leached.

Alkaline cyanide solution was continuously pumped from two 55-gallon drums through a carbon column and then distributed onto the rock through a set of glass capillary drip tubes. Flowrate of solutions was controlled by a variable speed drive on the pump, at approximately 288 liters per 24 hours (3.2 gallons per hour), or 0.0042 gpm per square foot of heap top surface.

FIGURE 8. SCHEMATIC DRAWING OF COLUMN LEACH TEST APPARATUS



The pumps and carbon columns presented schematically in Figure 8 can be seen in the photograph in Figure 9. The pumps are the cylindrical objects sitting in plastic pans on the wood platform next to the concrete leach columns. These are peristaltic positive displacement pumps, which are capable of moving solution, at very low flowrates, against high pressure or vacuum heads. The four white cylinders hanging above the pumps are the carbon columns, one for each leach system. Solution is pumped upward from the solution reservoirs located at ground level (two interconnected 55 gallon drums), through the carbon columns, then through clear plastic tubing to white PVC pipes. The pipes extend upwards to the tops of the leach columns where the gold-free solution is recycled onto the ore.

Each of the pumps contains two pump heads. The second pump head is slightly larger than the one described above; it is used to pump solution plus air out of the base of the leach columns and into the 55 gallon drums. The slightly higher flowrate of this pump assures that the column is continuously drained, which simulates the heap leach process.

Figure 10 is a photograph taken from ground level showing the location of the pumps and carbon columns on a raised platform about 12 feet above ground level. The view is partially inside, and partially outside the column building. The building can be seen rising another 30 feet or so above the elevation of the pump platform.

At the top of the building the four 3/4-inch PVC pipes connect to clear plastic tubing. As the photos in Figures 11 and 12 demonstrate, the clear tubing is drilled with a series of holes into which drip tubes are inserted. At normal flowrates (3.2 gallons per hour), each of the 40 tubes is dripping about 50 drops per minute of leach solution onto the top of the rock in the column. In Figure 11, column 4, which is loaded with the unoxidized, high-pyrite ore, is in the foreground. The other three columns contain oxidized ore. For the oxidized ore columns, the ore settled up to 3 feet once it became saturated with leach solution. This effect will be seen by comparing the level of ore in column one before leaching (Figure 12), and during leaching (Figure 11).

FIGURE 9. Photograph of the pumps and carbon adsorption vessels on the side of the leach columns. Two-headed peristaltic pumps, visible in the plastic trays at the bottom of the photo, pump solution by squeezing it through plastic tubing. One head pumps solution plus air from the base of the column at a slightly faster rate than the other head pumps solution through the carbon adsorption vessels, then 30-feet up to the distribution piping on the top of the leach columns.

The large white pipes are the carbon adsorption vessels. Carbon was removed and replaced up to four times during the leach period.

FIGURE 10. Photograph showing exterior-interior view of the column building. The carbon adsorption vessels and pumps shown in Figure 9, are located on a raised platform about 12 feet above the base of the leach columns. Total building height is about 50 feet.

FIGURE 11. Photograph of the distribution systems for leach solution on the top of the columns. Column 4, containing the sulfide ore mixed with limestone, is in the foreground. Columns one, two, and three have been under leach for several days, and the ore has settled up to three feet.

FIGURE 12. Photograph of column one before leaching has begun. All columns were loaded with 40-feet of ore, to within 6-inches of the tops of the columns. Solution was evenly distributed onto the ore through small glass capillary drip tubes.

Solutions in the 55 gallon drums were checked every 24 hours for for cyanide and lime content. Reagents were added as necessary to maintain "target" levels. Solutions were also analyzed daily, using AA methods, for Au, Ag and Cu to monitor the progress of the leach.

The charge of activated carbon was removed and replaced four times during the tests on columns one and three, three times on column two, and twice on column four. The carbon was assayed to determine the amount of gold and silver leached from the ore.

TEST HISTORIES

Rate of Gold Recovery. Gold levels in solution are shown graphically in Figures 13 and 14. The general shape of the recovery curve was the same for all four tests, and peak gold levels in solution were about the same for all tests, reaching 1.5 to 2.5 times the average concentration in the ore. (Solution gold levels peaked at 3.9 - 4.8 ppm, whereas ore contained 1.2 - 2.5 ppm gold.)

Figure 15 presents a tabulation of gold recovered onto carbon during various leach periods for the tall columns and the small bucket leach tests on the same ore samples. The gold recoveries tabulated there are presented graphically, versus leach time, in Figures 1 and 2.

Silver Recovery. Figure 15 also presents data showing levels of silver recovery. In the four tall column tests, an average of 1.5 ounces silver was recovered for each ounce of gold (bullion fineness was 408, or 40.8 percent gold, 59.2 percent silver). In the small bucket tests, recovery was approximately 1:1 (gold fineness 534). Individual samples show considerable variability.

Chemical Consumption. Consumption of sodium cyanide and of lime for the various leach periods is also tabulated in Figure 15. Chemical levels in solution are discussed in the following paragraphs.

Startup of Tests. The initial solution for all tests contained 1.0 grams NaCN per liter and 0.5 grams $Ca(OH)_2$ per liter. Initial solutions exiting the tests varied and are discussed separately for each column.

Column No. 1. Initial solutions exiting the column were acidic (pH 4.3) and contained no cyanide. Significant amounts of measureable "total" cyanide occurred the sixth day, but free cyanide did not occur till the pH became alkaline (pH $>$ 7.0) on day 30 after the addition of 0.26 pounds per ton lime.

In spite of the low initial pH, gold recovery began fairly early, and 33 percent of contained gold (50 percent recovered gold), was recovered onto the carbon column by day 41.

The column was leached steadily for 110 days. After day 110, the column remained dormant for 70 days, then it was restarted and leached for an additional 22 days. During this final leaching period, an additional 4 percent of contained gold (6 percent of recoverable gold), was recovered onto the carbon.

Fineness of recovered metal (parts gold per thousand parts gold plus silver) was 529.

Chemical consumption was 1.73 pounds per ton NaCN and 0.66 pounds per ton lime, with 41 percent of the chemicals consumed in the first 41 days.

Column No. 2. Initial solutions from column 2 were alkaline. Measureable cyanide in solutions did not become significant until day 16.

The rate of gold recovery was good, with 73 percent of contained gold (86 percent of recoverable gold) recovered by day 41 onto the carbon.

Fineness of recovered metal was 358.

Chemical consumption was 1.08 pounds per ton NaCN and 0.49 pounds per ton lime, with 57 percent of the chemicals being consumed by day 41.

Column No. 3. Initial solutions from column 3 were alkaline and contained measureable cyanide. Copper in solution rose sharply from 0.5 ppm on day 7 to 108 ppm by day 9. By the end of the test, copper in solutions had gradually risen to 250 ppm, which was the highest level achieved in any of the tests.

Even though measureable cyanide occurred early, the rate of gold recovery was similar to the slow rate achieved in column 1, which had remained acidic for several days.

By day 41, 38 percent of contained gold (54 percent of recoverable gold) was recovered onto the carbon. The low gold recoveries early in the test were probably a function of the high copper content of the leach solutions, which serves to "complex" available cyanide and prevent it from dissolving gold. The results seem to support a general metallurgical "impression" that the Dakota Maid Zone is generally higher in copper than the Sunday Zone.

Fineness of recovered metal was 427.

Chemical consumption in the test was 2.80 pounds per ton cyanide and 0.64 pounds per ton, with 31 percent of the chemicals consumed in the first 41 days.

Column No. 4. Initial solutions from column 4 were alkaline. Measureable cyanide in effluent solutions did not become significant until day 9.

Gold recovery was 0.025 ounces per ton by day 28 (64 percent of estimated contained gold and 78 percent of total recovered gold). Recoveries are based on carbon assays and an approximate ore weight of 18.1 tons. The ore weight and head assay are estimated, since the test has not been dismantled.

Fineness of recovered metal was 324.

Chemical consumption was low, with 0.77 pounds per ton NaCN and 0.33 pounds per ton lime being consumed over the duration of the test.

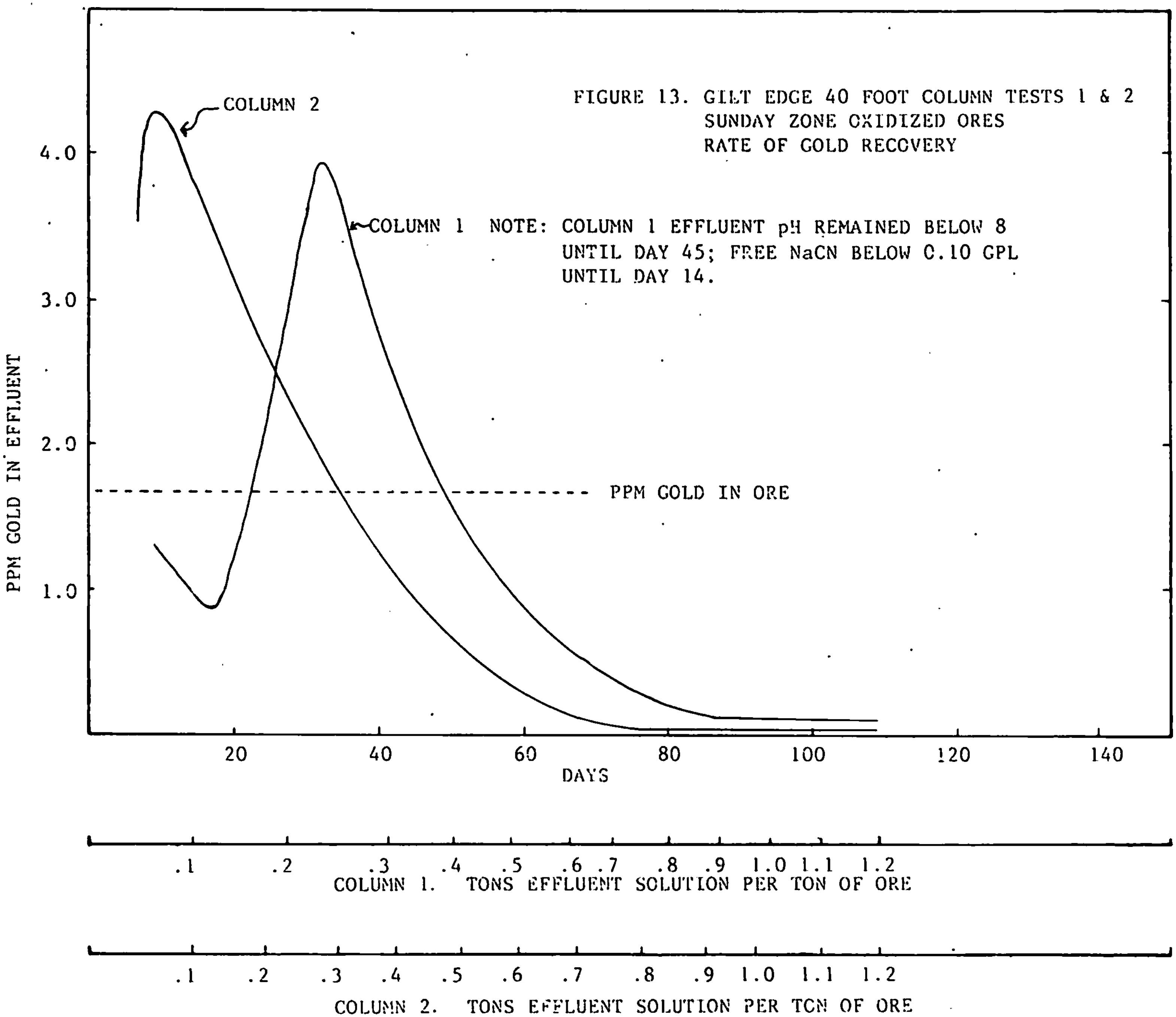


FIGURE 13. GILT EDGE 40 FOOT COLUMN TESTS 1 & 2
SUNDAY ZONE OXIDIZED ORES
RATE OF GOLD RECOVERY

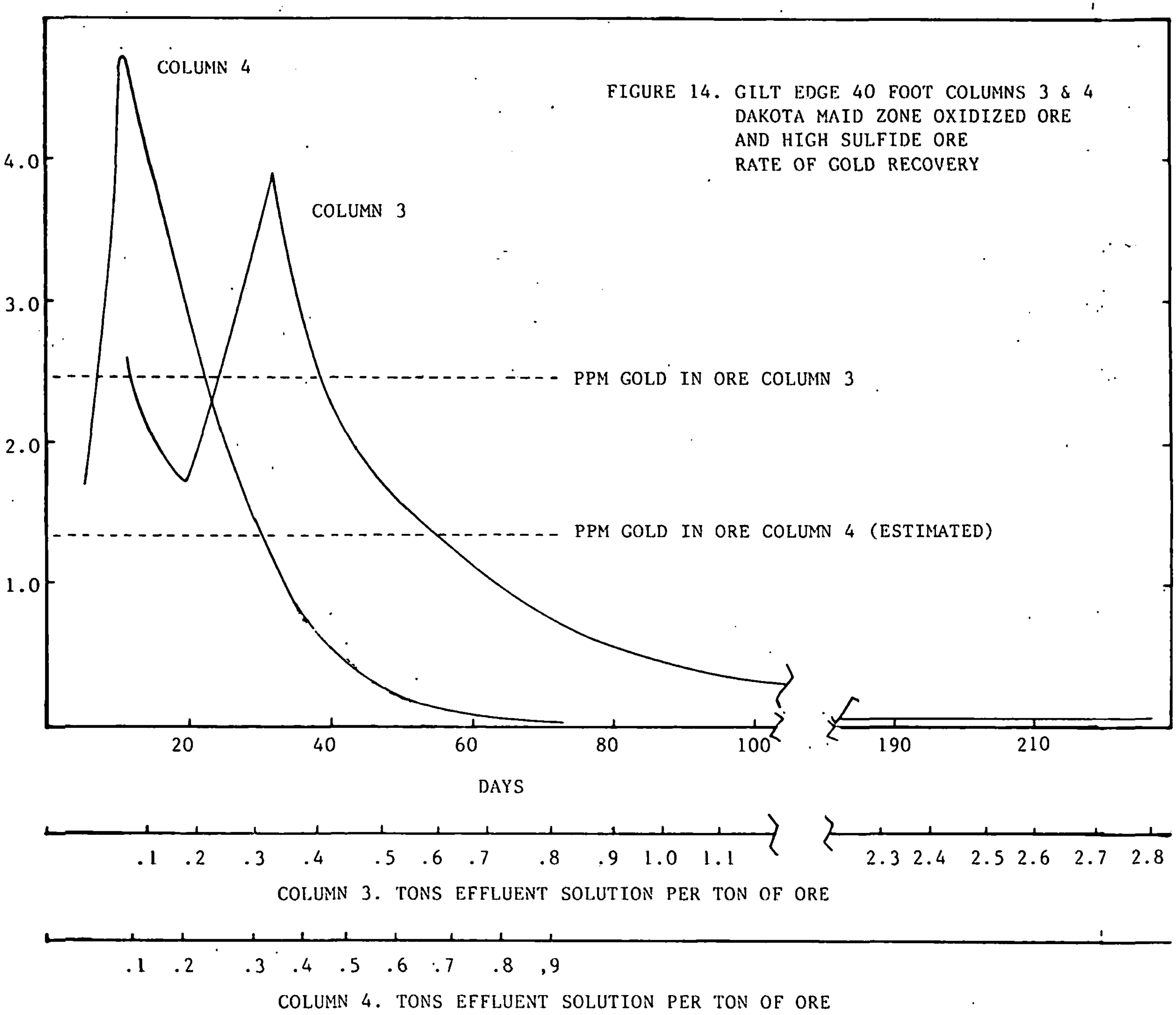


FIGURE 14. GILT EDGE 40 FOOT COLUMNS 3 & 4
DAKOTA MAID ZONE OXIDIZED ORE
AND HIGH SULFIDE ORE
RATE OF GOLD RECOVERY

FIGURE 15. GILT EDGE 40-FOOT COLUMN LEACH TESTS
AND COMPARISON WITH BUCKET LEACH TESTS
CARBON ASSAY RESULTS AND CHEMICAL CONSUMPTION

TEST NO.	CARBON PERIOD	METAL RECOVERED ONTO CARBON: OZ GOLD PER TON OF ORE	METAL RECOVERED ONTO CARBON: OZ SILVER PER TON OF ORE	PERCENT RECOVERY OF CONTAINED GOLD	PERCENT OF TOTAL RECOVERED GOLD	CHEMICAL CONSUMPTION LBS/TON OF ORE: NaCN	CHEMICAL CONSUMPTION LBS/TON OF ORE: $Ca(OH)_2$
COLUMN 1 SAMPLE: RATTLESNAKE OXIDIZED ORE							
Average of Tests 960 & 963	Day 12	.018	.007	30.0	54.5	1.16	0.94
	Day 56	.010	.006	16.7	30.3	0.97	1.51
	Day 100	.005	.004	8.3	15.2	1.08	0.70
	TOTAL	.033	.017	55.0	100.0	3.21	3.15
Column 1	Day 41	.017	.015	32.0	48.5	0.88	0.21
	Day 66	.011	.009	20.5	31.0	0.40	0.25
	Day 110	.005	.004	8.8	13.3	0.24	0.17
	Day 132	.002	.003	3.7	5.6	0.21	0.03
	Day 185	.001	.001	1.1	1.6	-0-	-0-
	TOTAL	.036	.032	66.1	100.0	1.73	0.66
COLUMN 2 SAMPLE: RATTLESNAKE OXIDIZED ORE							
Average of Tests 959, 961 & 962	Day 12	.033	.003	69.1	81.4	1.20	1.10
	Day 56	.006	.001	12.6	15.0	1.30	2.20
	Day 100	.001	.002	3.0	3.6	0.92	1.97
	TOTAL	.040	.006	84.7	100.0	3.42	5.27
Column 2	Day 41	.033	.070	72.6	85.8	0.76	0.21
	Day 66	.004	.001	8.6	10.2	0.15	0.17
	Day 110	.002	.000	3.4	4.0	0.17	0.11
	TOTAL	.039	.071	84.6	100.0	1.08	0.49
COLUMN 3 SAMPLE: DAKOTA MAID OXIDIZED ORE							
Average of Tests 1217 & 1218	Day 17	.041	.086	51.8	79.0	1.82	1.30
	Day 38	.006	.025	7.6	11.8	1.26	0.13
	Day 87	.005	.020	6.0	9.2	2.13	0.21
	TOTAL	.052	.131	65.4	100.0	5.21	1.64
Column 3	Day 41	.028	.005	38.3	53.9	0.90	0.20
	Day 66	.012	.031	16.0	22.5	0.45	0.20
	Day 171	.011	.014	15.0	21.1	1.00	0.22
	Day 229	.001	.019	1.7	2.5	0.45	0.02
	TOTAL	.052	.069	71.0	100.0	2.80	0.64
COLUMN 4 SAMPLE: DAKOTA MAID SULFIDE ORE							
Average of Tests 985 & 996	Day 27	.020	.038	50.8	99.6	1.64	1.30
	Day 58	.0001	.005	0.2	0.4	0.60	1.02
	TOTAL	.020	.043	51.0	100.0	2.24	2.32
Column 4	Day 28	.025	.055	66.0[1]	78.1	0.65	0.30
	Day 72	.007	.013	18.4[1]	21.9	0.12	0.04
	TOTAL	.032	.068	82.0[1]	100.0	0.77	0.34

1 - Estimated, based on assumed head assay, identical to calculated head assay of small bucket tests, 0.039 ounces gold per ton.

TAILINGS PREPARATION

After completion of the leach tests, the tailings from columns 1, 2, and 3 were removed, dried, and screened into seven size fractions for fire assaying. Column 4 was allowed to remain loaded in order to study effluents from sulfide tailings exposed to rainfall and weathering.

The procedure used to prepare the tailings was as follows:

1. As shown in the photographs in Figures 16, 17 and 18, the entire column was unloaded through a 14-inch diameter hole in the base of the column, and the test tailings were spread out on a sheltered, clean concrete floor to dry.

2. As shown in Figure 19, the dry tailings were then screened at 2-inches and 1-inch, and each size fraction was weighed (Figure 20).

3. The 2-inch, and the minus 2 plus 1-inch fractions were each crushed to minus 1-inch through a jaw crusher. Each size fraction was then coned and quartered until a sample of approximately 600 pounds was obtained.

4. The 600 pound portions from each size fraction were crushed further to minus 1/8-inch, through a gyratory crusher, and split into four equal portions using a Gilson SP-1 splitter.

5. Each quarter split was then split down to a 50 pound sample, which was crushed through a gyratory crusher to 100 percent minus 6 mesh.

6. A 2-pound sample of minus 6 mesh material from each quarter split was prepared, using a Jones splitter, then pulverized. A portion of the pulverized material was fire assayed.

7. The minus 1-inch fraction of the test tailings was handled similarly. It was coned and quartered until a 1-1/2 ton sample was obtained. The 1-1/2 ton portion was screened at 3/8-inch, 1/8-inch, 10 mesh and 65 mesh.

FIGURE 16. Photograph of column base showing method of removing tailings from the column. Ore flowed smoothly, and no problems were encountered using this method. Removal of the 25 tons of ore from a column took about one week.

FIGURE 17. Photograph of the interior of the sample drying shed. The wet sample was spread out on a concrete floor, then continuously stirred using a bobcat loader for several days until thoroughly dry.

FIGURE 18. Photograph showing the test tailings in late stages of drying, after removal of the large rock fractions.

FIGURE 19. Photograph of the vibrating screen used to separate the test tailings into size fractions.

FIGURE 20. Photograph of the weighing procedure. Each of the screened size fractions, after drying and screening, was placed into 55 gallon drums and weighed. Samples were checked for residual moisture to make sure drying had been complete. After weighing, the samples were split into smaller portions, which were transported to the Kappes, Cassiday laboratory in Reno for further reduction into fire assay samples.

8. Each of these size fractions was then weighed. The two size fractions above 1/8-inch were crushed to 100 percent minus 1/8-inch through a gyratory crusher. Then all samples were treated in the same manner as discussed in steps 4 through 6.

Figure 21 presents the tailings weights and assays for columns 1, 2 and 3.

ASSAYING PROCEDURES

Tailings Assays. Two assays from each tailings size fraction were run as one-half assay ton fire assays and two assays were run as one assay ton fire assays.

Carbon Assays. The loaded activated carbon, weighing approximately 20 pounds for each column change, was dried and weighed. Four samples were split out for fire assay and the reminder was stored for reference. The carbon for assay was roasted to convert it to ash, then conventionally fire assayed. The carbon assay results are presented in Figure 21.

Solution Assays. Approximate solution assays were made daily on an atomic absorption spectrophotometer using a standardized gold cyanide solution as reference. The solution assays were used merely to check on the progress of the leach since actual recovery was based on fire assay of the activated carbon.

Final solutions were checked by AA methods and found to contain negligible amounts of gold and silver.

FIGURE 21. GILT EDGE 40-FOOT COLUMN LEACH TESTS

TAILINGS WEIGHTS AND ASSAYS

SIZE FRACTION	COLUMN #1 WT. (lbs)	COLUMN #1 Au oz/ton[1]	COLUMN # 2 WT. (lbs)	COLUMN # 2 Au oz/ton[1]	COLUMN # 3 WT. (lbs)	COLUMN # 3 Au oz/ton[1]	AVERAGE WT. (lbs)	AVERAGE Au oz/ton
+ 2"	9,620	.022	12,219	.007	6,237	.028	9,359	.017
-2" + 1"	9,332	.016	7,934	.006	8,429	.024	8,565	.016
-1" + 3/8"	10,411	.022	6,147	.005	9,973	.021	8,844	.018
-3/8" + 1/8"	6,603	.013	5,657	.008	9,279	.020	7,180	.015
-1/8" + 10m	3,232	.014	4,272	.006	5,403	.017	4,302	.013
-10m + 65m	4,572	.017	6,493	.009	6,356	.017	5,807	.014
- 65m	2,031	.020	4,530	.010	3,278	.016	3,280	.014
WEIGHTED AVERAGE	45,801	.018	47,252	.007	48,955	.021	47,337	.016
OUNCES Au/ton RECOVERED		.035		.038		.051		
CALCULATED HEAD		.053		.045		.072		
PERCENT RECOVERY		66.0%		84.4%		70.8%		

1 - Average of four assays

NOTE: Figure A-1 in the Appendix contains corresponding data for the small bucket leach tests.

SMALL BUCKET LEACH TESTS USED TO PREDICT COLUMN RECOVERY

Head samples of ore from each of the 40-foot column tests, and samples of ore from the same locations taken during previous sampling campaigns, were tested in 50 pound laboratory bucket leach tests. The results of these smaller tests provide modeling and scaleup data for the tall columns.

As shown in Figures 1 and 2, and as discussed in the Summary section at the beginning of this report, the small bucket test results can be used to predict the recovery in the tall columns (and thus, hopefully, in production heaps).

The comparison between the tall columns and the small bucket tests is based on nine laboratory bucket leach tests. The test procedures and results are presented in the Appendix.

The tall columns represent essentially four sample locations through out the Gilt Edge orebody. A much larger number of sample sites - approximately 35 - have been tested in the small bucket leach tests. The results of this total program have been presented in a series of reports, and are summarized in the report dated July 6, 1982, titled "Report 1982 C - Summary Report, Metallurgical Evaluation 1978-1981, Gilt Edge, South Dakota".

Submitted by,

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APPENDIX

TO

GILT EDGE 40-FOOT COLUMN TEST REPORT

SMALL BUCKET LEACH TEST RESULTS

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2 August, 1982

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APPENDIX

SMALL BUCKET LEACH TEST RESULTS
GILT EDGE 40-FOOT COLUMNS

Several small bucket leach tests were run on samples of the same ore used in the 40-foot columns. Overall results are presented graphically in Figures 1 and 2 in the main body of this report.

The data used to generate the graphs resulted from a total of nine bucket leach tests. This appendix presents the procedures and results of those tests.

Even though the results of only nine tests were selected for the graphs, a total of 22 bucket tests have been run on the samples of ore used in the tall column leach tests. Fourteen of these - all on samples of ore used in columns one and two - were run on samples taken from the same underground locations as the tall-column samples, except that they were taken a year earlier as part of a separate bulk sampling program.

A summary of all 22 of the tests is presented in the following tabulations. Though individual test results vary slightly, all of the test data supports the general conclusions, that behavior in small bucket leach tests, and in tall columns, is identical except for time rate of recovery and chemical consumption.

In the following tables, the nine tests described here, and used for the recovery curves (text Figures 1 and 2), are marked with an asterisk. Details of tests in the 500 series have been previously described in a report dated 10 August, 1981, titled "Gilt Edge Field Sampling and Laboratory Tests, 1979 - May, 1980". Tests in the 790 - 810 series have been previously described in a report dated 10 November, 1981, titled "1979 Bulk Samples, Selected Large Rocks".

COLUMN 1: RED-BROWN OXIDIZED ORE, RATTLESNAKE ZONE

The tall column contained a composite of underground bulk samples No. 4 and No. 5.

BUCKET TEST NO.	SAMPLE LOCATION NO.	SIZE OF ROCK IN TEST	CALCULATED HEAD	PERCENT TOTAL GOLD RECOVERED
506	4	crushed to 2"	0.090	51.1
507	4	crushed to 5/8"	0.096	62.5
798	4	4-8" large rocks	0.172	51.1
960*	4	uncrushed, approx. 80% passing 2"	0.093	48.4
508	5	crushed to 2"	0.011	72.7
509	5	crushed to 5/8"	0.021	52.4
963*	5	uncrushed, 80% passing 2"	0.028	78.6
40-ft tall column		uncrushed, 80% passing 2"	0.053	66.0

While individual bucket leach test results on this sample are somewhat noisy, the results from similar tests, and the overall averages, are consistent. Tests 960 and 963 were run on small grab samples of the material actually placed in the 40-foot column, and were used for the Figure 1 curve. They averaged 63.5 percent recovery. Tests taken from the same underground locations the previous year, and leached at approximately the same size (506, 508), averaged 61.9 percent recovery.

COLUMN 2: YELLOW-BROWN OXIDIZED ORE, RATTLESNAKE ZONE

The tall column contained a composite of underground bulk samples Nos. 8, 9 and 14.

BUCKET TEST NO.	SAMPLE LOCATION NO.	SIZE OF ROCK IN TEST	CALCULATED HEAD	PERCENT TOTAL GOLD RECOVERED
514	8	crushed to 2"	0.027	63.0
515	8	crushed to 5/8"	0.025	72.0
799	8	4-8" large rocks	0.028	43.9
962*	8	uncrushed, approx. 80% passing 2"	0.062	87.1
516	9	crushed to 2"	0.038	84.2
517	9	crushed to 5/8"	0.040	85.0
800	9	4-8" large rocks	0.029	89.6
961*	9	uncrushed, approx. 75% passing 2"	0.038	79.0
526	14	crushed to 2"	0.032	90.6
527	14	crushed to 5/8"	0.035	100.0
802	14	4-8" large rocks	0.039	92.4
959*	14	uncrushed, approx. 60% passing 2"	0.042	88.1
40-foot tall column		uncrushed, approx. 75% passing 2"	0.045	84.4

For column two, both the calculated head assays and the percent recoveries are very stable and consistent. Tests 959, 961 and 962 were run on grab samples of the material actually placed in the 40-foot column, and were used for the Figure 1 curve. They averaged 84.7 percent recovery. Tests taken from the same underground location the previous year, and leached at approximately the same size (514, 516, 526), average 79.3 percent recovery.

COLUMN 3: LARON TUNNEL, DAKOTA MAID OXIDIZED ORE

BUCKET TEST NO.	SAMPLE LOCATION NO.	SIZE OF ROCK IN TEST	CALCULATED HEAD	PERCENT TOTAL GOLD RECOVERED
1217*		crushed to 2"	0.076	63.2
1218*		crushed to 5/8"	0.080	67.5
40-foot tall column		uncrushed, 87% minus 2"	0.072	70.8

COLUMN 4: KING TUNNEL, DAKOTA MAID SULFIDE ZONE

BUCKET TEST NO.	SAMPLE LOCATION NO.	SIZE OF ROCK IN TEST	CALCULATED HEAD	PERCENT TOTAL GOLD RECOVERED
985*	K-3	crushed to 5/8" with limestone added	0.042	47.6
996*	K-3	crushed to 5/8"	0.037	54.1
40-foot tall column		crushed to 1-1/2"	0.039(1)	82.0

(1) - Average of calculated heads from bucket tests.

SAMPLING

The 500 and 790-810 series tests discussed in the tabulation on the preceding pages, were run on portions of one-ton bulk samples taken in 1979. These tests and the sampling procedures are dis cussed in the reports cited on page 35.

Bucket leach tests 959, 960, 961, 962 and 963 were run on samples taken manually from 15-ton bulk stockpiles of the ore used in tall column tests one and two. The method of taking the 15-ton samples is described in the main body of this report, page 12. A total of five 15-ton samples - two for column one, and three for column two - were taken, and these were stored outside the entrance to the Rattlesnake Tunnel on wooden platforms. The bucket test samples, weighing 50 pounds each, were taken as "grab" samples by scooping ore with a shovel from several places around the stockpiles.

The ore in column three originated in a new adit called the Laron Tunnel, driven for sampling purposes into oxidized ore in the north end of the Dakota Maid ore zone. The 25-ton bulk sample for the column leach test was hauled from the tunnel site to the test site, and stockpiled on plywood. A 500 pound "grab" sample was taken from this stockpile by scooping the ore with a shovel from several places around the stockpile.

The ore for column four also originated underground, in the King Tunnel, and was handled similarly to the Laron Tunnel sample, except that, prior to placing on the stockpile, it was processed by crushing to 1-1/2 inches in a closed-circuit jaw crusher. A 500 pound grab sample was taken of the stockpiled ore after crushing.

It was thought that the handling and crushing procedures had mixed the sample for column four particularly well, however, the test results seem to show that the grab sample is significantly lower in gold content than the bulk sample. Since this tall column has not been dismantled, the discrepancy can only be estimated. For columns 1, 2 and 3, the tall columns were dismantled and the tailings were accurately assayed. As the tables on pages 36 through 38 show, the grab samples for these tests contained approximately the same gold content as the bulk samples.

SAMPLE PREPARATION

The five 50-pound grab samples from the 15-ton Rattlesnake Tunnel samples were setup as bucket leach tests without any further preparation.

The Laron Tunnel sample was prepared as follows:

1. The entire contents of the 55-gallon drum (500 pound sample) were dumped onto a clean concrete floor, and three 5-gallon buckets of material were cut out using a shovel.

2. The three buckets of material (designated sample 1013 J) were crushed through a jaw crusher set at 2-inches, the sample was mixed well, and then it was again split into three equal portions by removing alternating scoopfuls into each of three buckets. One bucket of 2-inch material was then setup as a bucket leach test (1217).

3. The remaining 2-inch material from sample 1013 J was crushed through a jaw crusher set at 5/8-inch. The sample was then divided by splitting through a Jones splitter into two equal portions, one of which was used for a 5/8-inch leach test (test 1218).

4. The remaining 5/8-inch material was split in half using a Jones splitter. Half was stored, and half was crushed to 100 percent passing 6 mesh.

5. Two 500 gram portions were split from the minus 6 mesh material, pulverized, and fire assayed.

The King Tunnel sample was prepared as follows:

1. The entire contents of the 55-gallon drum (500 pound sample) were further crushed through a jaw crusher to 1-inch (the material had been field crushed to 1-1/2 inches).

2. The sample was split repeatedly through a Jones splitter to yield four 5-gallon buckets of sample. Three of these were crushed to 5/8-inch through a jaw crusher and were used for subsequent testing. The remainder was stored.

3. One of the 5-gallon buckets was further crushed to 100 percent passing 6 mesh, then further split. A portion was pulverized, then fire-assayed for gold, silver and sulfur.

4. One of the 5-gallon buckets was further split in half. Half was stored, the other half was setup as "bucket" leach test 996 in a 3-inch diameter plexiglas column, to form a column of ore 54-inches high.

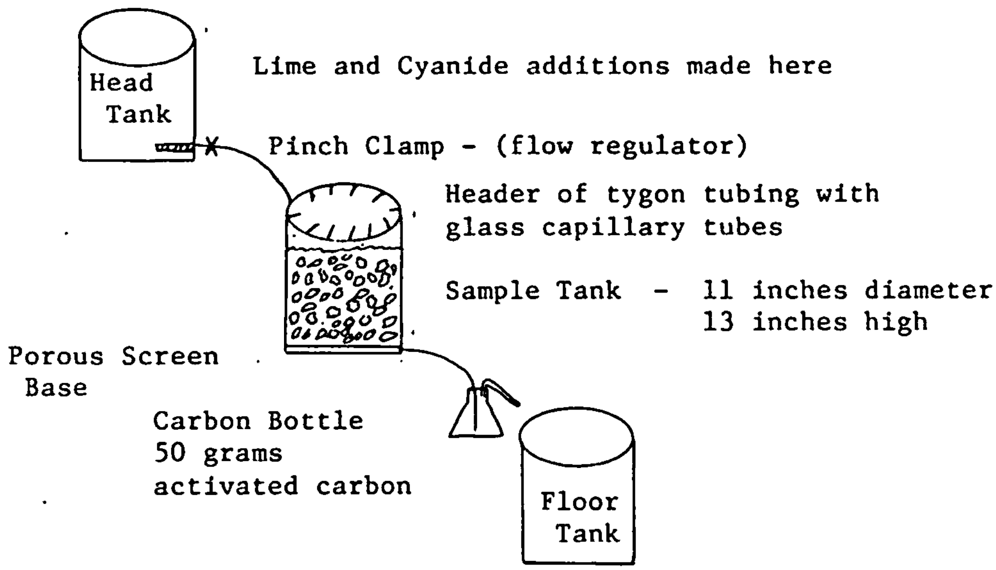
5. The remaining 5-gallon bucket was mixed with approximately 20 percent of its weight in crushed dolomite, then setup as bucket leach test 985 in a 6-inch diameter, plexiglas leach column, to form a rock column 40-inches high.

BUCKET LEACH TEST APPARATUS

The apparatus for the 2-inch and 5/8-inch leach tests is shown in the drawing on the following page. The apparatus for the two 5/8-inch leach tests on the King Tunnel sulfide sample, differed slightly, in that test 985 was conducted in a 6-inch diameter column, 40-inches high, and test 996 was conducted in a 3-inch diameter column, 54-inches high.

LEACH TEST PROCEDURE

In the apparatus shown, the center tank or leach tank, was filled with the rock to be leached.



Alkaline cyanide solution was continuously distributed onto the rock from the head tank through a set of glass capillary drip tubes.

Solutions exiting the leach tank flowed continuously through a bottle of activated carbon and then into the floor tank. The active solution in the system was recycled to the head tank every 48 to 72 hours.

Solutions entering the floor tank were assayed every other cycle for cyanide and lime, and reagents added as necessary to maintain solutions at "target" levels.

The charge of activated carbon was removed three times during the tests (twice on tests 985 and 996) and assayed to determine the amount of gold and silver leached from the ore.

TEST HISTORIES

Startup of Tests. The initial leach solution for all tests contained 1.0 grams of NaCN per liter and 0.5 grams of $Ca(OH)_2$ per liter. Individual test behaviors are discussed separately below. Chemical consumption is presented, along with gold recoveries, in Figure 15 of the main body of the report.

Rattlesnake Tunnel Samples, Tests 959 - 963. Initial solutions from all tests were alkaline and contained measureable amounts of cyanide. Cyanide strength was allowed to decline slowly during the first 60 days of the tests to a minimum of 0.1 to 0.5 grams per liter.

Alkalinity was generally maintained in the range pH 9.5 to 10.5 for the duration of the tests.

With the exception of sample 4 (test 960), rate of gold recovery was not significantly different between samples. On average, 65 percent of contained gold (81 percent of recoverable gold) was recovered onto carbon by day 12. Between day 12 and 56, an additional 11 percent of contained gold (14 percent of recoverable gold) was recovered onto carbon. Between day 56 and 100 an additional 4 percent of contained gold (5 percent of recoverable gold) was recovered onto carbon.

Laron Tunnel Sample (1013 J). Initial solutions from both tests (1217 and 1218) were alkaline and contained measureable cyanide. Cyanide levels were maintained in the range of 0.2 to 0.6 grams NaCN per liter for the duration of the tests. Alkalinity was maintained in the range pH 9.5 to 10.2.

Overall gold recovery was basically the same for both tests, averaging 65 percent of contained gold, with test 1218 on 5/8-inch ore showing slightly faster recoveries. On average, 52 percent of contained gold (79 percent of recoverable gold) was recovered onto carbon by day 17. Between days 17 and 38, an additional 8 percent of contained gold (12 percent of recoverable gold) was recovered onto carbon. Between days 38 and 87 (end of test), an additional 5 percent of contained gold (9 percent of recoverable gold) was recovered onto carbon.

King Tunnel Sample. Both tests on sample 983 were run on 5/8-inch rock. Test 996 was run on the crushed ore, while test 985 had dolomite added equivalent to 20 percent of the ore weight.

Initial solutions from test 985 were alkaline and contained measureable cyanide. Gold recovery was fast, with 99 percent of the recoverable gold (47.51 percent contained gold) recovered onto carbon by day 19.

Initial solutions from test 996 were acidic (pH 4.1), and were colored deep blue with prussian blue (acidic iron cyanide). Solutions remained slightly acidic for the first seven days of the test during which time approximately 35 percent of total contained gold (65 percent of recovered gold) had dissolved into solution. Ninety-nine percent of recoverable gold (54 percent of total contained gold) was recovered onto carbon by day 34.

TAILINGS PREPARATION

The test tailings were dried and screened into various size fractions. The individual size fractions were then crushed to 100 percent minus 6 mesh, if necessary. Two 500 gram portions were then split from each size fraction, pulverized and fire assayed. Tailings assays and weights are reported in Figure A-1.

ASSAYING PROCEDURES

Heads and Tailings Assays. Heads and tailings assays were all run as half assay ton fire assays.

Carbon Assays. The loaded activated carbon was dried and weighed. A sample of the carbon was split out and assayed and the remainder saved for reference. The carbon for assays was roasted to convert it to ash, then conventionally fire assayed.

FIGURE A-1. GILT EDGE 40-FOOT COLUMN TEST REPORT 1982 D

BUCKET LEACH TESTS ON SAMPLES OF ORE IN COLUMNS

OVERALL TEST RESULTS

TAILINGS WEIGHTS AND ASSAYS

Weight in Grams

Ounces per Ton Au

KCA TEST NO.	SAMPLE LOCATION	CORRESPONDING 40-FOOT COLUMN	SIZE FRACTION + 2"	-2 + 1/2"	-1/2" + 3m	-1/2" + 6m	-3m + 10m	-6m + 65m	-10m + 65m	-65m + 150m	-150m	WT. AVERAGE Au oz/ton	GOLD RECOVERED ONTO CARBON oz/ton of ore	CALCULATED HEAD ASSAY Au oz/ton	PERCENT GOLD RECOVERY
BUCKET TESTS ON COLUMN 1 SAMPLES: RATTLESNAKE OXIDIZED ORE															
960	4	1	4,680 .097	11,914 .042	2,672 .030	--- ---	3,752 .029	--- ---	2,734 .032	591 .049	150 .043	26,626 .048	.045	.093	48.4
963	5	1	7,145 .006	4,875 .004	3,025 .004	--- ---	3,555 .004	--- ---	2,650 .012	577 .011	810 .014	22,637 .006	.022	.028	78.6
BUCKET TESTS ON COLUMN 2 SAMPLES: RATTLESNAKE OXIDIZED ORE															
959	14	2	10,170 .005	6,670 .005	1,995 .004	--- ---	2,760 .004	--- ---	2,820 .005	840 .009	1,050 .009	26,305 .005	.037	.042	88.1
961	9	2	6,400 .006	9,457 .008	2,420 .012	--- ---	3,692 .008	--- ---	2,622 .010	578 .010	654 .009	25,823 .008	.030	.038	78.9
962	8	2	5,100 .010	5,410 .003	1,825 .005	--- ---	3,750 .007	--- ---	4,735 .011	1,125 .013	3,590 .012	25,535 .008	.054	.062	87.1
BUCKET TESTS ON COLUMN 3 SAMPLES: DAKOTA MAID OXIDIZED ORE															
1217	Laron Tunnel	3	--- ---	11,820 .030	3,250 .026	--- ---	4,210 .026	--- ---	2,430 .027	310 .035	450 .028	22,470 .028	.048	.076	63.2
1218	Laron Tunnel	3	--- ---	3,770 .035	8,210 .022	--- ---	6,440 .025	--- ---	3,420 .026	490 .032	640 .030	22,970 .026	.054	.080	67.5
BUCKET TESTS ON COLUMN 4 SAMPLES: DAKOTA MAID OXIDIZED ORE															
985[1]	King Tunnel	4	--- ---	12,631 .020	--- ---	7,375 .012	--- ---	8,258 .020	--- ---	1,790 .033	1,080 .017	31,134[2] .022[2]	.020	.042	47.6
996	King Tunnel	4	--- ---	5,871 .013	--- ---	4,145 .011	--- ---	1,970 .035	--- ---	583 .033	--- ---	12,569 .017	.020	.037	54.0

1 - 25 percent by weight dolomite added

2 - Actual tailings weights and assays are shown. The weighted average is adjusted to the original ore weight.

3 - Ounces per ton gold recovered onto carbon is tabulated in the text, Figure 15.

<u>Solution Assays.</u> Approximate solution assays were made periodically on an atomic absorption spectrophotometer, using a standardized gold cyanide solution as reference. The solution assays were used merely to check on the progress of the leach, since actual recovery was based on fire assay of the activated carbon.

Final solution was checked by AA methods and found to contain negligible amounts of gold and silver.

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